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(19)

(54) IMPROVEMENTS IN OR RELATING TO COMPRESSION MOULDING APPARATUS

(71) I, THE SECRETARY OF STATE FOR DEFENCE (formerly THE MINISTER OF AVIATION SUPPLY), London do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to moulding apparatus and to a method of moulding.

The invention is particularly concerned with the moulding of lattice structures using material comprising a fibrous reinforcement in a cured synthetic resin matrix.

According to the present invention apparatus for moulding a lattice structure comprises a jig, blocks of elastomeric material corresponding to the shapes of the lattice spaces and locatable upon the jig, and pressure plates locatable upon the blocks, the shape of the lattice being defined by the jig, the sides of the blocks and the pressure plates and the apparatus being adapted so that in use the elastomeric material may be deformed by compression between the pressure plates and the jig to form a desired cross section of the lattice members.

Especially advantageous elastomeric materials include silicone rubbers and certain polyurethane rubbers which will neither inhibit cure of nor bond to the resin charge. Moreover composite of elastomeric materials of different elasticity may be used.

The invention is useful for moulding structural articles of composite material comprising a fibrous reinforcement such as glass or carbon fibre in a cured resin matrix. For maximum structural efficiency it is desirable that such articles should be of the right cross-section and that the orientation and distribution of the fibres within the article should be in a preferred form. It is thus the function of the elastomeric blocks not merely to enable applications of a curing pressure but to provide the article with the preferred cross sectional shape and fibre distribution. Such a preferred shape may be an I-section or an approximation thereto.

According to a feature of the invention a method of moulding a fibre reinforced plastics material lattice structure, utilising apparatus defined above may include the steps of laying fibre and resin between the blocks when mounted on the jig, locating the pressure plates on the blocks and applying pressure thereby to the blocks to deform them so as to form a predetermined cross-sectional shape to the finished article, and curing the resin or allowing it to set.

The invention is illustrated by way of example in the accompanying diagrammatic drawings of which:

Figure 1 is a cross sectional view illustrating the principle invention, and

Figures 2 and 3 are perspective and end elevations of a lattice structure mould.

As shown at Figure 1 a rectangular mould cavity is defined between a base plate 11, a pressure plate 12 and two side blocks of rubber 13, 14. In use and for moulding a composite material comprising carbon fibre reinforcement in a cured synthetic resin matrix, carbon fibres impregnated with resin and hardener are laid length-wise of and to fill the mould cavity with the pressure plate 12 removed. The plate 12 is then positioned as shown and a load applied in the direction of the arrows A and B to reduce the thickness of the rubber blocks 13, 14. As a result the inner faces of the blocks 13, 14 bulge inwardly as indicated by the dotted lines at 15, 16. Cure of the resin is now effected whilst the pressure is maintained. After cure the moulded article is removed from the mould.

The cross section consequently produced

[Price 25p]

is of a modified I shape, and thus has a structural efficiency of the order of that of an I-beam.

A lattice structure mould is shown at Figures 2 and 3 for producing a hollow hexagonal cross section lattice with an equilateral triangle pattern.

The mould has a solid walled jig 21. Silicone rubber blocks 22 are detachably mounted on the jig by means of pins 23 which are a tight fit in the blocks 22 and project into holes in the jig. The blocks 22 are shaped so that between adjacent blocks is a channel 24 bottomed by the jig 21, the channels being interconnected to form the pattern of the lattice. The sides of the blocks are shaped according to the wall shape they will impart to a strut of the lattice when under pressure. The channels are to be closed by edge clamps 25 and pressure plates 26. The clamps 25 and the plates 26 run the length of the jig. The plates 26 are stepped at their side edges to engage with the edge clamps 25 so that for each side of the hexagon the inner surface of the appropriate sides of the two clamps 25 and of the plate 26 are in the same plane. The plates 26 are provided with slots. Bolts 27 pass through the slots and corresponding holes in the blocks 22 to locate in screw threaded holes in the jig. These can be used to apply pressure through the plates 26 and clamps 25 and the contents of the channels.

In use the rubber blocks 22 are mounted on the jig 21. The channels 24 formed by the blocks 22 and the jig 21 are filled with resin impregnated fibres with the fibres extending length-wise of the channels. The edge clamps 25, pressure plates 26 and bolts 27, are located over the blocks 22 and the bolts are tightened so that the blocks are deformed. A torque spanner may be employed to ensure uniform pressure and block deformation.

After resin cure has been effected the clamps, pressure plates, rubber blocks, are removed and the lattice slid off the jig 21.

As an alternative to applying pressure through bolts a vacuum bag may be used, or an autoclave, or both.

A method of filling the channels which tends to ensure satisfactory strength at the rods includes the use of a tow of wet or dry impregnated fibre. While cold curing can simply be effected while maintaining the pressure on the charge, for hot curing heaters may be fitted into the mould.

The mould cavities defined between the deformable blocks may be of other than initially rectangular finally modified-I-cross section. The initial shape of the sides of the blocks can be designed for any post pressure shape available from the rubber. Furthermore, for differential block deformation, composite blocks may be made using elastomeric materials of different elasticity.

WHAT I CLAIM IS:—

1. Apparatus for moulding a lattice structure and comprising a jig, blocks of elastomeric material corresponding to the shapes of the lattice spaces and locatable upon the jig, and pressure plates locatable on the blocks, the shape of the lattice being defined by the jig the sides of the blocks and the pressure plates, and the apparatus being adapted so that in use the elastomeric material may be deformed by compression between the pressure plates and the jig to form a desired cross section of the lattice members.

2. Apparatus as claimed in claim 1 and wherein the elastomeric material is a silicone rubber.

3. Apparatus as claimed in claim 1 and wherein the elastomeric material is a polyurethane rubber.

4. Apparatus as claimed in claim 1 wherein the elastomeric material is a composite of material of differing elasticity.

5. Apparatus as claimed in any one of claims 1 to 4 and wherein bolts are employed to locate the pressure plates and to apply the pressure.

6. Apparatus as claimed in any one of the preceding claims and having heaters fitted to the jig.

7. A method of moulding a fibre reinforced plastics material lattice structure, utilising apparatus as claimed in any one of the preceding claims, and including the steps of laying fibres and resin between the blocks when mounted on the jig, locating the pressure plates on the blocks and applying pressure thereby to the blocks to deform them and thus impart a predetermined cross-sectional shape to the finished structure, and using the resin or allowing it to set.

8. Moulding apparatus substantially as hereinbefore described with reference to the accompanying drawings.

9. A method of moulding substantially as hereinbefore described with reference to the accompanying drawings.

10. A moulding made upon apparatus as claimed in any one of Claims 1 to 6 and claim 8.

11. A moulding made by the process as claimed in Claim 7.

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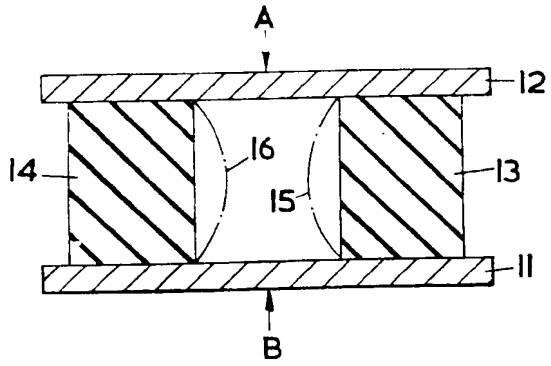

FIG. 1.

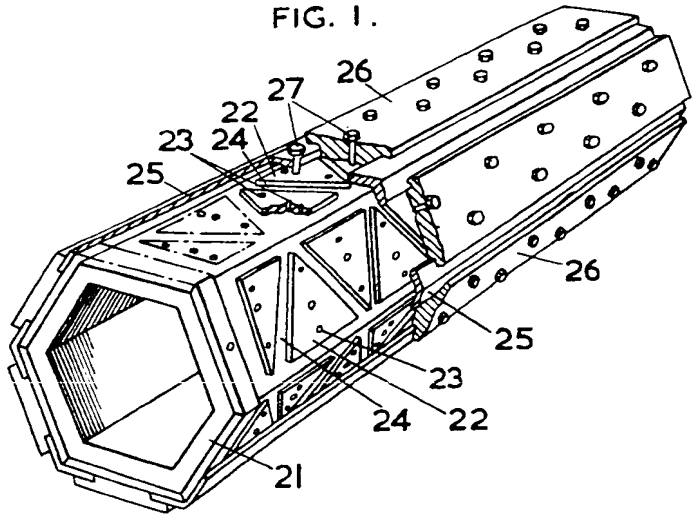

FIG. 2.

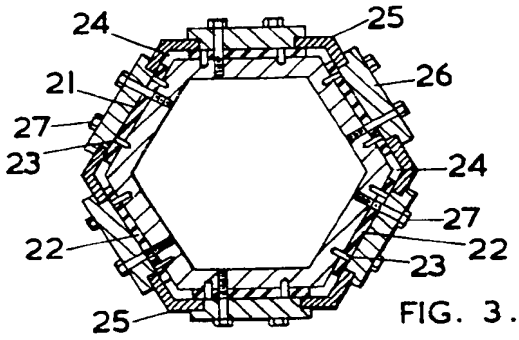

FIG. 3.